

MANUAL OF CIVIL DEFENCE Vol. I

PAMPHLET No. 2

Radioactive Fall-out

Provisional Scheme of
Public Control



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RADIOACTIVE FALL-OUT

Provisional Scheme of Public Control

(NOTE.—The Medical Research Council's Report on "Hazards to Man of Nuclear and Allied Radiations" (Cmd. 9780), published in June, 1956, makes a sharp distinction between the peacetime radiation hazard and the dangers that would arise from the use of nuclear weapons in war. It recognises that fall-out from ground-burst thermo-nuclear weapons would result in doses "several thousand times greater than those we have considered as possible peacetime hazards".

Further study of the effects of whole-body gamma radiation—especially the effects of cumulative doses—will be required before the highest medical authorities can express a view on the plans for protecting the population from fall-out in war. This provisional scheme has, accordingly, had to be drawn up on the basis of the best advice available at the time of its preparation.

The principles set out in this Memorandum and the details of the scheme are being referred to the Medical Research Council for their study and comment. It is hoped to take account of the results of this study in later versions of the Memorandum.)

I. Preliminary

1 Scope of the Scheme. This Memorandum outlines the principles and, to some extent, the procedure for securing control in areas affected by the residual radioactivity resulting from the explosion of a nuclear weapon burst on or near the ground. The object of the scheme is to lay down the lines on which the control of the public, assumed to be in their homes and billets or at their places of work, should be organised. It is directed to establishing a framework within which more detailed planning of the activities of various essential services can take place and to providing a basis for the progressive instruction of the public on what they should do under fall-out conditions. The Memorandum has many limitations, and four of the most important should be recognised from the outset:

- (a) the proposed procedure does not make provision for the control of rescue and other life saving work by the operational services, including the armed forces, in areas of moderate damage near to ground zero. The harmful effects of radiation would not, however, discriminate between one individual and another and the plans of the various services will have to take account of the principles set out in this Memorandum;
- (b) the application of the control scheme in practice may be considerably affected by the period of time over which an attack on the United Kingdom extends;

(c) no attempt is made to deal with contamination of growing crops and other agricultural hazards (e.g., to milk), nor with the difficulties confronting hospitals and other comparable institutions or the principal public utility services such as water, electricity, gas, communications, transport or food distribution. For each of these, fall-out presents serious new problems which are being tackled by the Departments and services concerned in the light of the principles embodied in this Memorandum;

(d) it is recognised that the role assigned to the wardens in the scheme described in the Memorandum may overlap that of the police. The precise relationship between these two closely associated services varies according to local arrangement, and it would not have been useful to attempt to deal with it in general terms in the present Memorandum which does not purport to deal with police duties under fall-out conditions.

2 Gamma radiation—background information. The Home Departments' publication "Nuclear Weapons" (Manual of Civil Defence: Vol. 1: Pamphlet No. 1) contains in Chapter III technical information on nuclear radiation hazards relevant to an understanding of the provisional control scheme. The table reproduced in paragraph 62 of "Nuclear Weapons" sets out the probable effects on people of a single exposure to gamma radiation. The problem of equivalent "spread-over" doses is much more difficult but, on the best advice available and pending a considered appreciation from the Medical Research Council, it is considered that a dose of 60 roentgens spread over two or three days or 200 roentgens spread over a year would be no more likely to cause radiation sickness than a dose of 25 roentgens spread over three or four hours. The numbers incapacitated from a single dose of up to 25 roentgens would be negligible, and this is the limit which it is proposed should be accepted by civil defence and other workers sent into a contaminated area for a short spell of duty.

3 The long-term consequences of exposure to gamma radiation should not be overlooked. These include: reduced resistance to certain diseases; shortened expectation of life; and genetic effects. The present scheme sets out to safeguard the public, so far as possible, against the immediate dangers of fall-out; this involves concentrating mainly on reducing the amount of radiation sickness. If such sickness can be kept to a minimum, the incidence of the long-term effects will also be restricted.

II. Principles of the Provisional Scheme

4 General. The principle of keeping radiation sickness to a minimum is fundamental to the whole scheme. The average house can be made to give a useful degree of protection against radioactivity. It would be a question of using that protection to the best advantage. Theoretically, provided they were in adequately protected accommodation and had food and water, the longer people could avoid coming into the open the better. But theory needs to be reconciled with practical considerations. Thus the strain of close confinement would be considerable for adults, let alone children, and the scheme would break down if it attempted to secure compliance with a discipline more severe than

the people affected could be brought to understand was necessary in their own interest. Moreover, the earliest practicable release of areas flanking the main fall-out zones would be indispensable so that the community could mobilise its resources to assist the more seriously affected areas.

- 5 The dominant characteristics of fall-out for which the scheme of control must allow are: (a) its persistence; and (b) the wide extent of the areas that would be simultaneously affected. In the early stages decay of radioactivity would be rapid. Seven hours after the burst the dose rate measured in roentgens per hour (r.p.h.) might be one-tenth of the rate at one hour; after two days the rate might be one-hundredth. Thereafter radioactivity would continue to decay, but the reduction with time would become relatively less significant. In these circumstances it is necessary to select an optimum time for the initiation of action, and the balance of advantage would appear to be with selecting 48 hours after burst for this purpose, especially for the areas of highest intensity from which, as explained in paragraph 38, the population would have to be removed; further delay would not bring corresponding benefits. The plans of the public authorities would accordingly be based on a controlled resumption of activity in a large part of the fall-out area after about 48 hours. The precise timing would be a matter for decision at the time and might be affected by the general pattern of the attack. Care would in any case have to be taken to avoid creating in the minds of the public an expectation of a return to normal after a precisely determined interval; the public at large would have to be advised to be prepared to stay in refuge for 2-3 days or more until area by area they were told under what conditions it was safe to come out.
- 6 The extent of the area affected would place a high premium on the greatest possible degree of decentralisation. The emphasis must necessarily be on self-help, and it has already been recognised that under fall-out conditions "the household becomes the basic unit" (Statement on Defence, 1956—paragraph 102). The system of control by which individual households would receive guidance and help should be based on the smallest practicable local units. These units would require to be linked with a central system of control and co-ordination, but would have to be able, if communications failed, to function to some extent on their own initiative. The need to have small units is reinforced by the fact that in parts of the fall-out area variations are to be expected in dose rates over comparatively small distances, and it would be important to avoid imposing precautions over unnecessarily wide areas related to a particular range of dose rates. Information and guidance related to *local* conditions must reach the street and hamlet, or rather the individual house and farmstead, if there is to be any worthwhile control at all. It is accordingly intended to adopt, for purposes of the control scheme, the unit of the warden's post area. It is recognised that this decision will have a considerable effect on warden's post areas and on the functions of the Wardens Section.
- 7 One further general aspect of the scheme deserves mention. There would be no means of knowing before the event the extent of radioactive contamination that would be caused by any one ground-burst megaton weapon. The intensity and extent of radioactivity and its distribution would vary within wide limits according to: (i) the yield

or power of the bomb; (ii) the extent to which the fireball was in contact with the ground, i.e., the height of burst; (iii) the speed and direction of the wind at all heights up to about 100,000 feet; and (iv) the nature of the soil at ground zero. These uncertainties are a necessary element of the problem of devising a control scheme, and it will be essential to plan the scheme so that it could come into operation anywhere in the country and virtually simultaneously over very wide stretches of territory, perhaps in the greater part of two or three regions for one bomb. Moreover, except as a result of forecasting based on meteorological conditions at the time, there could be no fore-knowledge of where the highest intensities of radioactivity would occur. It follows that the aim should be for every warden's post unit—and indeed for every household—to be prepared and equipped so that it could, if necessary, operate under the worst conditions of radioactivity. When warning of fall-out was given, it would be necessary for all to assume the worst until the actual level of radioactivity had been determined in their own locality.

8 State of Preparedness. In elaborating this scheme, it is necessary to make some assumption on the degree of preparedness which it would be the Government's aim to achieve. Public education in these matters will be progressive during the next few years, and it is assumed that, if the threat of war increased, there would be some increase in the tempo of civil defence preparations by individuals no less than by public authorities. For present purposes, the following assumptions have been made:

- (a) that the public at large would have been instructed—by means of a Householders' Handbook supplemented by intensive use of other means of publicity, including broadcasting and television—in the measures each household should take to help itself. Such a handbook would include details of the control scheme and instructions as to the significance of the fall-out zones set out on page 11 of this Memorandum;
- (b) that most households would, on Government advice, have obtained a sufficient stock of food and water to enable them and those who were billeted on them to survive for a period—not less than one week's supplies should be the rule;
- (c) that most people would have a fall-out refuge in their house or elsewhere giving a protection factor of 40 against radioactivity. (The protection factor is the factor by which the outside dose has to be divided to get the inside dose—see "Nuclear Weapons", paragraphs 87–93.) With the windows blocked with sandbags or an equivalent, a ground-floor room in a two-storey terrace house or in a semi-detached house built of 13½-inch brick would provide this standard of protection; it should be possible to attain a higher standard of protection in larger buildings, e.g., blocks of flats or tenements. Time spent in places with a protection factor of 40 is referred to subsequently as "In refuge"; and
- (d) that elsewhere in a house, billet, or at their place of work, everyone would have a measure of protection giving a factor of 10. Time spent in such places with this protection factor is referred to subsequently as "Under cover".

9 Significance of Protection Factors for the Scheme. The assumptions at (c) and (d) of paragraph 8 are critically important for the classification

of the fall-out areas into zones, which is the basis of the present scheme. The general objective has been to divide the fall-out area into zones of radiation intensity and to work out a system under which the doses likely to be received by people in the different zones would result in few, if any, cases of radiation sickness provided that the control rules were complied with. This involves an assessment of average cumulative doses that would be acceptable under the circumstances.

- 10 Some people would, no doubt, find better protection than the assumed refuge, e.g., in a basement. Others, for a wide variety of reasons, might not have the benefit of protection as high as 40. They might be unable to improve the protection factor of their house or billet sufficiently to reach this standard, or they might not treat seriously a danger that they could neither see, smell, nor touch. These variations must be accepted; they do not invalidate the approach adopted for this scheme. Disregard of the rules suggested for public behaviour, whether from bravado or ignorance, would bring its own penalty; there could be little in the way of enforcement in the ordinary sense of the term since neither police nor wardens would be able to patrol the fall-out area.

III. The Warning System

- 11 The development of a fall-out warning system, supplementary to the system for giving warning of the attack itself, is proceeding. The Royal Observer Corps would monitor fall-out so as to provide the Air Raid Warning Organisation with the data on which to base public warnings of fall-out. Warnings would be issued in the fall-out area wherever an intensity of radioactivity in excess of 0.3 roentgens per hour was expected to occur.
- 12 At the present stage it is not possible to do more than outline the general objectives of the warning system, since these may be modified in the light of experience as development proceeds. The extent to which the existing siren system can be adapted for the purpose remains to be determined. It is clear, however, that the public would need to know how they stood in relation to: (i) the attack; and (ii) fall-out. Effort is, therefore, being directed towards providing the following code:
 - (i) *The attack warning itself*—the wailing note on a siren (or other signal device) giving warning of air attack, initiated by the warning message “Red”.
 - (ii) *Cancellation of this warning*—warning message “White”—would also be by siren (or other signal device).
 - (iii) *A warning of imminent danger of fall-out*—by siren (or other signal device) hereafter called warning message “Black”. This message would originate with the national warning organisation, though there might also be a need in certain circumstances for local origination of a fall-out warning based on actual readings and given by some means other than siren, possibly whistles. This warning would convey the meaning: “Take refuge and remain there until you are told what to do”.
 - (iv) *A cautionary fall-out warning*—to be given by siren (or other signal device) to areas thought to be in the path of the fall-out.

This warning—message “Grey”—would also originate with the national warning organisation. It would be based on forecasts of the probable path of the fall-out and would signify that there was serious danger of fall-out occurring, but that time was available for last minute preparations before taking cover. The question of a precise timing of the signal will have to be determined after further study of the possibilities of long-term forecasting; but clearly it should forecast some minimum interval before the message “Black” would be issued to the district. Provisionally it might be regarded as signifying that one hour at least would elapse before the arrival of fall-out at the boundary of the warning district nearest to ground zero.

There might also be a need for a wireless broadcast announcing that fall-out producing weapons had been used and giving guidance to the public on what they should do. This might be in addition to, or in substitution for, the “Grey” warning.

- 13 Cancellation of the warning message “Black”, i.e., the release of the public from the warning to take cover, would need to be carried out on a combination of local and national information. The actual release would, in the main, have to be done locally and progressively, but to initiate the release procedure local controls would need to receive a “Blue” message signifying that: (a) fall-out was complete in the district; and (b) no further fall-out was threatened from any bomb already dropped. This message would permit the institution of local release procedures subject to a check of actual readings taken locally. To provide for the case where, in the event, “Grey” was not followed by “Black”, it might be desirable to have a cancellation of “Grey” (by means of a “Green” message). A “Green” message might also be used to cancel a “Black” message in areas where no fall-out had been deposited.
- 14 While responsibility for issuing the “Black” message and giving the warning signal would normally rest with the national organisation, special problems would arise in relation to the area of damage surrounding ground zero. In this area there might well be damage to warning devices or associated communications which in some cases would make it difficult for a nationally originated warning to be given. Moreover, in the area damaged by blast and fire there would be urgent tasks to be carried out by civil defence personnel and the public on the spot, e.g., extinguishing small fires, giving first aid to casualties and removing exposed casualties to shelter. It would be neither practicable nor desirable to attempt to keep everyone under cover in such circumstances, since fall-out might not occur throughout the area and, where it did, there might be some delay in its appearance which could be profitably employed in life saving and other urgent tasks. There would be a need for special arrangements to give local warning in such areas when a significant degree of fall-out was detected.
- 15 It would be particularly important to ensure that the public were aware that a “Black” warning was still operative in their areas. A prolonged warning without clear evidence of its cause would be apt to lose its effect and be disregarded. It is planned that B.B.C. staff and broadcasting facilities will be located at regional headquarters and broadcasting might prove a useful means by which the continuing

threat could be emphasised, but some kind of visual signal might prove practicable in some areas (*cf.*, the hoisting of storm cones).

16 The following is a summary of the possible warning pattern:

| MESSAGE | HOW GIVEN | MEANING |
|-------------------------------------|---|--|
| <i>A. Attack Warning Messages</i> | | |
| Red | To the public (by siren or other signal device) | Imminent danger of attack—take shelter. |
| White | To the public (by siren or other signal device) | Raiders Passed. |
| <i>B. Fall-out Warning Messages</i> | | |
| Grey | To the public (by siren or other signal device) | Danger of fall-out, but at least one hour before its expected arrival. |
| Black | To the public (by siren or other signal device) | Imminent danger of fall-out—take refuge until further advice is received by word of mouth. |
| Blue | To controls by telephone | Fall-out complete and no further fall-out threatened from any other bomb already dropped. Release procedures may be initiated. |
| Green | To the public (by siren or other signal device) | Cancellation of Grey or Black. |

NOTE: The messages have for convenience been grouped under two heads. This should not be taken as indicating the sequence in which they might occur. In particular, a Grey message might be issued to areas where the Red attack warning was still in force.

IV. Categorisation of Zones

17 The basis proposed for the scheme of control is the division of fall-out areas into zones of radiation intensity, for each of which a drill to be observed by the public can be prescribed. In this and the succeeding sections, the zones are described. The method of establishing them and the bearing of the proposals on the responsibilities of the civil defence and other services are considered in a concluding section.

18 The letters W, X, Y and Z would be used to identify four kinds of zone. The zone category would, for the most part, be determined by the dose rate in roentgens per hour (r.p.h.) at 48 hours after burst, i.e., as a general rule 1/100th of the rate at 1 hour. This basis of

definition is proposed chiefly for the reasons given in paragraphs 4 and 5, but there are also the following grounds for its adoption:

- (i) the fall-out would not have travelled far in the first hour and at most would only be complete close to ground zero. Over the larger part of the fall-out area the dose rate at 1 hour would thus be a theoretical concept only;
- (ii) generally, except in Zone W (see Section V) or in the damaged area, no action out of doors would be required or should be encouraged, in the fall-out area within the first 48 hours;
- (iii) there would be advantages in basing action in the fall-out area on a predicted dose rate at 48 hours which could be verified from instrument readings at the time. This would provide a safeguard against any variation in the decay rate and a check on predictions based on the dose rate at 7 hours (1/10th of the rate at 1 hour) which would be used for the provisional determination of boundaries.

19 The determination of fall-out zones and the institution of the control plan would be independent of operations by the civil and military forces to deal with casualties and damage in the area close to ground zero. Such operations, which would call for a balancing of the radiological hazard to the participants against the results they might be able to achieve in a given time, could best be conducted on the basis of actual dose rates measured at the time.

20 As explained in paragraph 7, any estimate before the event of the area which would be affected by fall-out could at best be speculative; it is clear, however, that it is necessary to think in terms of some thousands of square miles. The data published about the American nuclear weapon test in March, 1954, refer to an area of 7,000 square miles in which survival might have depended on prompt evacuation of the area or upon taking shelter; and to an area of 14,000 square miles in which a cumulative dose in the open of 100 roentgens or more was recorded in the 24–48 hours after the detonation. The control scheme, if it is to achieve its object of keeping sickness to a minimum, would have to operate in the initial stages for even lower doses than this. The area affected by fall-out from a megaton weapon attack would probably be of such dimensions as rarely to develop its full extent over the land surface of the United Kingdom. A ten megaton bomb might well result in an actual dose rate of 0·3 r.p.h. (the lowest reading which could reliably be taken with existing radiac survey instruments) being measured up to 1,000 miles from ground zero and the contaminated area might at its widest part be 80–100 miles across. Within this area, the territory in which control measures would need to be observed after the initial 48 hour period (Zones X, Y and Z) might still be some 450–600 miles long and 35–50 miles across.

21 The table on page 11 gives a summary of the zones and the recommended and permissible action in them.

Radioactive Fall-out—Summary of Provisional Control Zones

| Zone | Definition of Zone Boundaries | Range of Cumulative Doses in open at 48 hours | Summary of permissible and recommended action | Range of Cumulative Doses assuming observance of control rules |
|------|---|---|--|--|
| W | Outer: Limit of area placed under "Black Warning" (see Footnote). Inner: 0·3 r.p.h. at 48 hrs. | Up to 80r | Complete release from refuge as soon as dose-rate fell to 0·3 r.p.h. or, if the rate had not reached that figure, when fall-out was complete. | At 48 hrs. Below 2r |
| X | Outer: 0·3 r.p.h. at 48 hrs. Inner: 3 r.p.h. at 48 hrs. | 80–800r | Qualified release from refuge after 48 hrs.—indoor workers to follow normal occupations, but not to exceed 4 hrs. per day in the open. Outdoor workers to work half shifts for next five days. At the end of this period the zone would be normal, except that all would be advised to be out of doors as little as possible and not in any case to exceed 8 hrs. per day in the open for the next three months. | At 48 hrs. 2-20r At 7 days 6-60r At 5 wks. 12-120r At 3 mths. 14-145r |
| Y | Outer: 3 r.p.h. at 48 hrs. Inner: 10 r.p.h. at 48 hrs. | 800-2,800r | Release from refuge under stringent control after 48 hrs. For the next 12 days people should not leave their refuge for longer than necessary. Time in the open should not exceed 2 hrs. per day and time under cover, but not in refuge, a further 8 hrs. On this basis essential indoor workers should be able to get to their places of work, but outdoor work would remain suspended; a relaxation would be possible after the first fortnight and further easement in another three weeks. For the rest of the first year, however, people in this zone should not exceed 8 hrs. a day in the open. | At 48 hrs. 20-70r At 14 days 50-170r At 5 wks. 70-240r At 3 mths. 95-330r |
| Z | 10 r.p.h. at 48 hrs. | Above 2,800r | All movement outside refuge accommodation in this zone would be dangerous. People should remain in refuge until instructions for clearance were given—they should then leave the zone by the quickest available route if they had means of transport or wait in their refuge to be collected if they had not. The clearance operation might start after 48 hrs. and removal from the zone would be for at least 3 months. | At 48 hrs.—Above 70r |

The initial Zone W boundary would be defined by the boundaries of a series of warning districts on the flanks of the fall-out. After 48 hrs. Zone W would for public control purposes have disappeared: its outer boundary would have moved during the period to coincide with the outer boundary of Zone X. The question of defining an area extending in some places beyond Zone W in which there might be an agricultural hazard is being studied.

V. Zone W

- 22 Characteristics of Zone W.** Zone W would cover the fringes of the fall-out area. It would be potentially a very extensive area, but in the United Kingdom would be unlikely to develop to its full extent before reaching the coast. Its outer boundary would initially be the limits of the warning districts in which a warning message "Black" had been issued, signifying imminent danger of fall-out; its inner boundary would form the outer boundary of Zone X. During the first 48 hours Zone W would contract as the dose rate fell below 0.3 r.p.h. After 48 hours the zone would cease to exist for public control purposes, though an agricultural hazard might remain.
- 23** The proposals for Zone W are designed to ensure that no one would get a short-term dose of more than 6r even if he spent the whole of the next 12 hours in the open after being released: it is not proposed to impose any greater restriction on anyone than would be consistent with the attainment of this objective. Given good discipline in the first 2/3 days, all the people in this zone would be able, without restraint, to play their full part in the work of restoration, decontamination and recuperation. The aim would be progressively to release them all at the earliest moment it was safe to do so. After release they would be able to regard themselves as unaffected by radiation and would be able, if required, to enter and work in more heavily contaminated areas on the same terms as people not affected by fall-out.
- 24 Establishing the outer boundary.** The first problem would be to establish an outer boundary and to guard against traffic crossing the boundary and penetrating the fall-out area. The necessary action would have to be taken outside any area to which the "Black" fall-out warning was given. As soon, therefore, as a warning district received the "Black" warning, it would be for all the wardens posts immediately outside the boundary (except any which were themselves already under the "Black" warning or received it concurrently) to put up notices, in co-operation with the police, on the boundary of the "Black" district, bearing the legend:

" DANGER—FALL-OUT "

- 25** The technique of posting of warning notices requires to be worked out both generally and in detail. At this stage it is sufficient to say that through roads, especially trunk roads, would receive first attention. The exhibition of notices would not entail the setting up of road blocks or the risk of exposure of personnel to radioactivity. The purpose of the notices would be informatory, i.e., to ensure that no person or vehicle proceeded further along the road in ignorance of the danger they might run. This procedure would have to be followed whether or not the wardens posts on whom the duty fell were themselves under the "Red" or "Grey" warning.
- 26 Contraction of Zone W.** By the means outlined in paragraphs 24 and 25, a provisional control line would be established on both flanks of the fall-out area along the boundaries of the warning districts under the "Black" warning. During the next 48 hours the objective would be systematically to release the area within the control line up to the boundary of Zone X and to do this as rapidly as possible. This

would be achieved by adding individual wardens post areas or groups of post areas to the free zone beyond the provisional control line as soon as it became safe to do so. The general criterion for this purpose would be when the radioactivity reading for a particular area, or areas, had fallen to 0.3 r.p.h. As the radioactivity decayed, the true 0.3 r.p.h. line would move continuously towards the fall-out axis at a speed which was, however, unlikely to exceed $\frac{1}{4}$ mile in an hour; it would move even more slowly where the contours were closest together near to ground zero. The Zone W boundary would contract in rough conformity with this movement (see paragraphs 51-53).

- 27 Release procedure.** For a variety of reasons, which would apply with even greater force to the higher intensity zones, release of the public from restrictions after fall-out had occurred could not be effected by a general siren signal. When an area was released, it would be necessary to ensure that everybody in it was made aware of the conditions applying to that area and of such continuing precautions as they should, in their own interest, observe. In the main, this would have to be done by wardens by a house to house notification, though in some cases it might be possible to speed up the process, e.g., by the use of public address equipment mounted in vehicles.
- 28** The inhabitants of a released area in Zone W would be told that they had been in such a zone, that they were now free of all restriction, that they were unaffected by radioactivity, but that they should conform with the public notices marking the limits of the free zone. Wardens would initiate release action on being authorised to do so by their local control.

VI. Zone X

- 29 Characteristics of Zone X.** This would be a zone of comparatively light contamination; its extent would, however, be considerable, perhaps 450/600 miles long and 35/50 miles wide for a 10 megaton weapon. It would be a zone in which, once the period of 2/3 days after burst had elapsed, something closely approximating to normal working conditions would have to be restored forthwith; the area would have to cease to be a liability on the rest of the nation, except perhaps as regards agricultural products. The dose rate in the area, which would have ranged from 30 r.p.h. up to 300 r.p.h. at 1 hour after burst, would have fallen to between 0.3 r.p.h. and 3 r.p.h. The dose received by people in the area at the end of 48 hours, assuming they had spent this time in refuge, would have been between 2r and 20r. For the rest of the first week (i.e., the next five days) they should not spend more than 4 hours per day in the open, but freedom for up to 4 hours should enable the great majority of people to go about their normal business. For the remaining 20 hours of each day, they should be advised to spend as much time as possible in their refuge, but in any case indoors. Provided they remained under cover, their dose would not be seriously increased. At the end of the first week, people in Zone X would be freed from restraint. If the time such people would, on average, thereafter subsequently spend in the open is put at 8 hours per day, the cumulative dose of people in the zone would, assuming a protection factor of 40 for their refuge, lie between 14 and 145r at the end of three months with a possible further increase of

2-25r during the remainder of the first year. These figures take no account of further possible reduction by the physical removal of contamination, e.g., down the drain, whether by weathering or decontamination. It is accordingly reasonable to assume that very little, if any, radiation sickness would occur in the zone. It is possible that the cumulative doses would be reduced if effective decontamination could be undertaken both by householders and the public authorities, but there are considerable practical difficulties about this.

30 Further consideration needs to be given to the position of outdoor workers in the zone, many of whom perform duties of first importance—agricultural workers, police, transport staffs, etc. Strict control of their hours of work after the general release had taken place would be an obvious requirement.

31 Establishment of the boundary and release procedure. The outer and inner boundaries of Zone X would be determined in accordance with the procedure described in Section IX of this Memorandum, and the roads crossing the inner boundary (which would also be the outer boundary of Zone Y) would require to be marked after the lapse of 48 hours in the same way as described in paragraph 24. The marking boards would be more mandatory in character, e.g.,

“ DANGER—FALL-OUT
ZONE Y STARTS HERE
NO ENTRY ”

When the word for release was given, wardens would have to use the time they were permitted to spend in the open notifying the inhabitants of their areas that they were in Zone X; that they could leave their houses for limited periods, but should spend as much time as possible indoors under cover, either at home or at their place of work. For the next five days they should avoid being in the open as far as possible and in no case for more than 4 hours a day. They should not regard themselves as available for work in the higher intensity Zones Y and Z, but could play a very significant part of preparing aid for those in Zone Y. The members of any household who wished to leave the zone and had the means to do so could not be prevented from moving, but they should be warned of the intense overcrowding of all accommodation likely to be found elsewhere and of the dangers of being unable to find adequate shelter in the event of another attack. They should be encouraged to recognise the greater claim of others to leave the innermost zone and to exercise restraint by staying put.

VII. Zone Y

32 Characteristics of Zone Y. In this zone stringent precautions would be essential; initial dose rates in the open might be as high as 1,000 r.p.h. Though much smaller than Zone X, it would still cover a large area; a 10 megaton weapon might give rise to a Zone Y up to 20 miles wide and some 200 miles long. Even after 48 hours, the dose rate in the open would range between 3 r.p.h. and 10 r.p.h. and the inhabitants of the zone (who, if in refuge affording a protection

factor of 40, would already have taken between 20 and 70r) would, if they were not to become sick, have to act with discipline and discretion. Virtually their only concern for the whole of the first fortnight would be with their own radiological safety. For this period they would need to restrict the time spent out of doors to, say, 2 hours per day at most, and the time which they spent out of their refuge, but under cover, to a further 8 hours per day. Even after 14 days, they would need to continue to remain under cover as far as possible and should not, in any event, be in the open for more than 4 hours per day for the next three weeks; and 8 hours per day for the rest of the first year. Assuming observance of such a discipline, the cumulative dose of people in the zone would lie between 95 and 330r at the end of three months and between 125 and 430r at the end of the first year.

- 33 After the first 2/3 days, Zone Y would begin to come to life again. There should not be much sickness in the zone in view of the time over which the dose of 20–70r would have been spread. The bulk of the people in the zone would, however, have to continue to stay within doors and be prepared to nurse such of their number as fell sick, without aid or advice other than such general guidance as might have been issued beforehand or be relayed to them by broadcast. It would be important to ensure that the permissible 2 hours in the open was turned to good account. Within households, there would be scope for spreading the risks by sending out individual members to perform necessary services for all. Careful organisation would be required to avoid more people emerging at the same time, e.g., to get food, than could be attended to promptly. It is to be hoped that many, if not most, of the people would contrive to spend less than the allowed time in the open; they should not, in any event, go far from their homes or billets. Properly utilised, the 2 hours should none the less enable them to exist under tolerable conditions. It would permit visiting of near neighbours and short journeys to get essentials, preferably by bicycle or car. Only the most urgent of outdoor tasks could be performed by people already in the zone, but key personnel required as reliefs for the operation of essential services would be able to report for duty, provided protection was available for them at their places of work.
- 34 As with Zone X, people should be discouraged from leaving the zone. The keynote of policy should be that people in the zone would be safe, provided they were sensible and observed the recommended precautions. The departure of those who had the means to take themselves out of the area could, however, hardly be prevented; indeed it might be that some arrangements for removing young children with their mothers would prove to be feasible. The transit dose of radiation for a journey by car from the inner contour of the zone after 48 hours would amount to about 3 roentgens.
- 35 **Establishment of the boundary and release procedure.** This would not differ in principle from the corresponding action in Zone X. Each warden would have less time in which he could be expected to play his part in establishing contact with householders to give them guidance on the local situation. The arrangements for marking the inner boundary of the zone (i.e., the beginning of Zone Z) would be of less urgency and importance than in the outer zones.

VIII. Zone Z

- 36 Characteristics of Zone Z.** The dose rate in this zone would be 1,000 r.p.h. or more at 1 hour after burst; at 48 hours it would still be 10 r.p.h. in the open at the outer contour. If people in the zone had had the benefit of a protection factor of 40 in their refuges, the minimum cumulative dose would be about 70r and much higher doses would be received in parts of the zone. On its outer fringes, the zone would contain people for whom there would be good hope of escaping any serious effects. Further towards the fall-out axis and closer to ground zero, sickness, of which symptoms might be beginning to appear after about 48 hours, would be general. In the inner part of the zone, lethal doses of radiation would be received by some, and the entire population would be suffering various degrees of incapacity. The chances of ultimate survival of many of these might be slender.
- 37** The contour enclosing Zone Z might extend for a distance of 70–100 miles from the ground zero of a 10 megaton bomb; it might enclose an area up to 12 miles wide. These figures, like other zone dimensions given in this Memorandum, need to be treated with reserve; they provide an indication of the scale on which control operations would have to be conducted—no more. In the case of Zone Z there are special grounds for emphasising this factor: not only must allowance be made for the variables affecting fall-out mentioned in paragraph 7, but decisions taken in the aftermath of the attack might critically affect the determination of the zone boundary. The action to be taken in respect of the zone, as the following paragraphs show, would be drastic, and there would be a consequent need for flexibility in the classification of wardens post areas on or near the boundary, e.g., by the adoption in places of another (higher) contour. The weight of the enemy's attack and the resulting situation elsewhere in the country at the time might be the deciding factors.
- 38 Procedure in (and in relation to) Zone Z.** The discipline proposed in paragraphs 32 and 33 for Zone Y is regarded as the most severe with which substantial compliance by a population of all ages could be expected. It follows that any attempt to organise communal life in Zone Z would fail and that wholesale clearance of the zone would have to be undertaken, if sickness and death were not to overtake the great majority of people in it. After 48 hours radioactivity would continue to decay, but at a relatively slower rate. Since people could not remain indefinitely in the zone, the sooner the process of their removal could be started after 48 hours the better.
- 39** Clearance of Zone Z would be a combined operation. There could be no way of knowing in advance how many people would have to move, but they would be likely to be numbered in 100,000's. The broad scope of the operation and its timing, together with any related broadcasting of information, would have to be dealt with at regional headquarters where the military, police, transport and civil defence welfare interests would be represented. For purposes of its detailed planning, the zone would have to be broken down into small but manageable units. Efficient conduct of the operation would call for the collaboration of those inside the zone with their rescuers.
- 40** No one could be sent into the zone until 48 hours had elapsed; the interval would have to be used, however, for making preparations to

bring all available resources to bear as soon as action became possible. These preparations would be of three main kinds:

- (a) broadcast instructions designed not merely to sustain morale but to prepare people in Zone Z to co-operate in their own relief and, in particular, to convey to those who had their own transport when to move and in what direction;
 - (b) preparation of reception centres in Zone W and beyond and preliminary planning of the clearance movement; and
 - (c) marshalling transport and organising teams to conduct the clearance operation.
- 41 Self-help within the zone.** The first lift would make use of vehicles already within Zone Z, mainly, no doubt, private cars, but not excluding motor and pedal cycles and any commercial vehicles whose drivers could get them on the road without going far on foot to collect them. Broadcast instructions would give these people a broad indication of the time when they should start and of the areas outside Zone X where they might expect to find arrangements made for their reception. It would be stressed in the broadcast advice how important it would be for no one to leave the zone with less than a full load; people would, however, be leaving the zone for a period of some months and would have to bring some personal effects with them. Traffic control would be an important police problem. The movement would, however, be one-way, and the broadcast instructions could be used to secure some kind of spread-over to ease the situation at the reception end. It would be important to guard against outgoing vehicles impeding transport entering the zone to conduct the second phase of the clearance operation.
- 42** Some people, who had their own transport, might not receive the broadcast instructions either because they had no wireless set or because of electricity failure. These people, if not told by neighbours of the instructions given to those with their own transport, would receive any necessary instructions when transport arrived to conduct the main part of the clearance operation.
- 43 Preparation of reception centres in the free zone.** Population density in parts of the country would already be high as a result of the pre-attack evacuation movement. A further population movement into, and through, these areas would produce acute difficulties of reception and billeting as well as of traffic control. The organisation of a large number of reception centres, preferably conveniently sited for further movement by rail, would have to be undertaken before clearance started; people using their own motor transport should be routed through to areas well beyond the areas in which reception centres were set up.
- 44 Marshalling of transport and organisation of teams.** It would be unsafe, however, to rely on the self-help movement described in paragraph 41 accounting for more than a quarter to a third of the normal population of the zone; allowance must also be made for the effect of the pre-attack evacuation which might have doubled the population in the zone. Wireless broadcasting would need to be used to the fullest extent to explain to the remainder the plans being made to help them; only thus could they be kept in good heart and be convinced of the necessity to remain in their refuges until their turn came. The

clearance operation would necessarily be spread over some time and might be delayed for a period for the inner areas; people would need to be forcefully reminded that they should not venture into the open except on a direct summons.

- 45** The first requirement in planning the operation would be for the zone to be broken down into small areas which could be assigned to clearance teams; the wardens post area would be the natural unit for this purpose as it is for the control scheme itself. Each team, under the charge of a clearance officer, would have the task of completely clearing its allotted post area, and the movement would take place from as many areas as possible concurrently. During the waiting period, clearance officers would themselves be briefed, study the areas assigned to them and make detailed arrangements with their allotted transport drivers as soon as these reported. The clearance officer would move in to his assigned area in Zone Z as soon as practicable after authority to start the movement was given and establish himself at the wardens post.
- 46 Conduct of the Clearance Operation.** The clearance officer would supervise the operation, acting in conjunction with the post warden; it would be unsafe to rely on the post warden alone who might well be incapacitated. Occupants of houses, who had not moved out, would have been told to signal by way of a window card or other similar device that they were ready to leave when called for. Transport assigned for the operation would report to the clearance officer and be detailed systematically to cover his allotted area. The best procedure would probably be to concentrate on one street at a time. Wardens and street leaders might assist when transport arrived in their own streets by knocking at the doors of all houses displaying the appropriate sign; the aim should be to ensure that no one vehicle spent more than 30 minutes in the zone collecting its load. When the clearance officer was satisfied that all who wanted to leave had been able to do so, he and the post warden would withdraw. The question of people who did not wish to leave their homes or billets in Zone Z would be a thorny one. They might include people with a degree of protection comfortably above average and a good store of food and water and their own means of transport. In the nature of the case there could be no enforcement, only persuasion, itself based on public education before the event. Clearance of the area would imply that the public services would not be restored for a considerable time; no one would be able to stay indefinitely.
- 47** The timing of any clearance operation would be a matter for decision at the time. It could not begin before 48 hours had elapsed, but there are obvious psychological and other reasons why it should not start much later. The state of the air battle might influence the decision.

IX. Operation of the Control Scheme

- 48** The control scheme described in this Memorandum will place new and important obligations on regions, on local authority controls, and on the civil defence services, especially wardens. The precise manner in which these obligations would be discharged will have to be determined over a period of time as a result of practical trials and

experience. This section accordingly attempts only to sketch in very general terms the tasks to be performed and to outline how they might be carried out.

49 Fixing the Zone boundaries. Regions and the central government would receive a forecast and subsequently a picture of fall-out as it was taking place from the monitoring organisation established, *inter alia*, to provide the information on which the warning system described in Section III would operate. This would be based on readings provided by a network of some 1,500 Royal Observer Corps reporting posts, and it would provide a broad appreciation of the fall-out situation. It would not be sufficiently detailed to settle the precise zone boundaries, but it would provide what was needed at the highest levels of control in the early stages of fall-out. Each zone boundary on the ground would need to be identified as rapidly as possible by the boundaries of a connected chain of wardens post areas determined by the appropriate controls from among the 19,000 or more wardens posts in the country; identification of the posts forming this chain would be a slower process. The procedure for settling the zone category of wardens posts, and the resulting fixing of zone boundaries, is likely to be on the lines indicated in the succeeding paragraphs.

50 To avoid wardens being exposed to radioactivity while fall-out was coming down, they would not normally be expected to take dose rate readings until instructed to do so by the appropriate control after the dose rate had begun to decline. The instruction to start taking readings would be given after receipt of the "Blue" message signifying that fall-out was complete. Readings would not necessarily be called for from all posts in a given local authority area immediately, especially if, by sampling, the control discovered high dose rates which made an early decision on the zone category unnecessary. The control (which would have been informed of the time of burst to which to relate its predicted dose rates at 48 hours and, as the information became available, of the rough location of contours) would probably be able to judge which of its posts were critically placed for purposes of settling zone boundaries and would start by collecting readings from those posts. With this information fairly accurate categorisation of wardens post areas should be possible, subject to any necessary checking by higher levels of control, especially as regards the junctions of zone boundaries with adjoining control areas. Posts in Zones X and Y would, on completion of this process, be notified of their zone category and of the time at which they should set in motion the appropriate release procedure; Zone Z posts would be told to await further information on the plans for clearing the zone; Zone W would be dealt with as described below.

51 Controlling the movement of the W Zone boundary. The determination of the W Zone and the regulation of its effective boundary would be of most importance in the early stages. After calling for dose rate readings from its posts, the control would have discretion to release immediately post areas where the reading was already below 0.3 r.p.h. provided the post was not flanked by other posts with substantially higher readings. Before any post which abutted on the area of another control was released, consultation with that other control would be essential as a precaution against higher readings

just over the boundary and to find out whether or not warning notices were required to be exhibited at the boundary.

52 When a W Zone post was released by its control, the wardens would have two main duties:

- (a) if informed by control that their post had an area not yet released on one flank, to put up "DANGER—FALL-OUT" notices at the boundary of their post area on all roads leading into that area ; and
- (b) to cancel the fall-out warning for their area and remove any notices which had served their purpose.

53 The release of the rest of Zone W would be based on a system of standard release times—e.g., at 0600, 1200, 1800 and 2359 hours (four hourly intervals might be possible). As soon as the initial release of fringe posts had been put in hand, control would calculate for each of its post areas the times at which it expected the dose rate to drop to 0.3 r.p.h. On the basis of this calculation, proposed release lines at the standard times would be passed up through the various levels of control for confirmation. Each level, e.g., County or Region, would rectify any inconsistencies between adjoining areas. Provisional release times would be notified by controls to all posts in Zone W as soon as the local proposals had been checked and any necessary modifications made. It would then remain only for posts to take a reading one hour before each standard release time to enable the control to check that the radioactivity was decaying as expected. By this means the outer boundary of the fall-out area would move in systematic fashion across Zone W and warning notices would be exhibited or removed at each stage as appropriate.

54 Controlling the clearance of Zone Z. The planning and conduct of the clearance operation described in Section VIII would involve many agencies. While the local authorities and the Warden Section within Zone Z would have a part to play, it seems impracticable for the operation to be controlled by them; this would have to be done from outside the zone. The marshalling and direction of the transport movement on the scale required would be an immense task. There would be evident scope for assistance by the Army in such an operation and considerable responsibilities would, in the nature of the case, fall to the police. The broad scope and timing of any clearance operation would rest with the Regional Commissioner, but it might prove desirable to entrust detailed planning and execution of the movement to a specific service. This will be further examined.

55 Role of the Warden Section. From the references throughout this Memorandum to the duties of wardens, it will be evident that a whole range of new duties will be entrusted to them under the scheme. The effect of these new obligations on the functions of the Warden Section is being studied.

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